Programme Specification: Undergraduate

For students starting in Academic Year 2017/2018

1. Course Summary

Names of programme(s) and award title(s)	BSc (Hons) Physics BSc (Hons) Physics with International Year (see Annex A for details)
Award type	Dual Honours/Major/Minor *NB:* all students who study a science Principal subject are candidates for the degree of Bachelor of Science (with Honours) (BSc Hons) irrespective of their second Principal subject.
Mode of study	Full time
Framework of Higher Education Qualification (FHEQ) level of final award	Level 6
Duration	3 years 4 years with International Year
Location of study	Keele University – main campus
Accreditation (if applicable)	This subject/programme is accredited by: The Institute of Physics (IoP) – for further details see section 12
Regulator	Higher Education Funding Council for England (HEFCE)
Tuition Fees	**UK/EU students:** Fee for 2017/18 is £9,250* **International students:** Fee for 2017/18 is £14,150** *(if combined with a non-laboratory-based Principal Subject)* *or* £15,250** *(if combined with a laboratory-based Principal Subject)* The fee for the international year abroad is calculated at 15% of the standard year fee
Additional Costs	Refer to section 18

** These fees are regulated by Government. We reserve the right to increase fees in subsequent years of study in response to changes in government policy and/or changes to the law. If permitted by such change in policy or law, we may increase your fees by an inflationary amount or such other measure as required by government policy or the law. Please refer to the accompanying Student Terms & Conditions. Further information on fees can be found at http://www.keele.ac.uk/studentfunding/tuitionfees/*

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How this information might change: *Please read the important information at http://www.keele.ac.uk/student-agreement/. This explains how and why we may need to make changes to the information provided in this document and to help you understand how we will communicate with you if this happens.*

2. What is a Dual Honours programme?

Dual Honours degrees are degrees that are taken in two different subjects, resulting in an *X and Y* degree title, for example *Physics and Mathematics.* If you are taking a Dual Honours programme, these will be the two subjects you applied for. These are referred to as your Principal Subjects.

In a Dual Honours degree you must take at least 120 credits in each Principal Subject, accrued over all three levels of study, with at least 30 credits in Year 1 (Level 4) and at least 45 credits in each of Years 2 and 3 (Levels 5 and 6) in each of two Principal Subjects. The remaining available credits can be filled with modules from these subjects or other subjects entirely.

What is a Major/Minor programme?

Major/Minor degrees are degrees that are taken in two different subjects, much like a Dual Honours degree, except that you will specialise in the Major subject. In a Major/Minor degree you will need at least 225 credits in your Major subject over your three years of study with at least two modules (30 credits) taken each year in your Major Subject, although some Principal Subjects will require you to take more than this and this will be stated in the relevant programme specification. You will also need 90 credits in your Minor subject with a minimum of 30 credits (two modules) taken in Year 1 (Level 4) and 45 credits (three modules) taken in Year 2 (Level 5).

Students taking the Minor Route in Physics might not necessarily be able to demonstrate that they have achieved all of the Programme's learning outcomes. Hence the Minor Route in Physics will NOT be accredited by the IoP.

3. Overview of the Programme

Physics is one of the fundamental curiosity-driven science subjects that has been known to widely contribute to other areas of sciences and a range of industries such as power, nuclear, electronics, telecommunications, medical, pharmaceutical and food technology. In addition to the subject knowledge, Physics curriculum incorporates a number of transferable skills that can be widely exploited in research, education and in a wide variety of industrial sectors. This is evidenced by the wide range of positions being held by Keele Physics graduates.

The three year Dual Honours Physics programme at Keele aims to cover all of the topics which are defined as "Core Physics" by Institute of Physics (IOP) for all undergraduate Physics degrees in the UK. On successful completion of the Physics programme at Keele, students will be equally qualified and well prepared for postgraduate studies or graduate level employment.

All the required instruction in Mathematics and Computing to study Physics is incorporated within the Physics modules. We operate an open-door policy which enables students to have excellent and flexible access to staff to seek advice or feedback on their work. Activities in year 1 and 2 Laboratories are designed such that students should be able to develop necessary competence in laboratory activities by the end of year 2 and be able to undertake individual project in year 3.

4. Aims of the Programme

The broad aims of the programme are to:

- You will achieve a knowledge and understanding of the fundamentals of Physics and be able to apply this knowledge and understanding to solving problems.
- You will develop competence in the application of mathematics and computing to physical problems.
- You will develop competence in laboratory activities by the end of year 2 and have undertaken project work both individually and within a team by the end of year 3.

- You will acquire a range of subject-specific skills including how to formulate and tackle problems in Physics; how to plan, manage, execute and report the results of an investigation; how to use mathematics to describe the physical world; and how to deploy these skills to tackle issues within the subject.
- You will acquire a range of cognitive, generic and transferable skills including problem-solving skills, investigative skills, analytic skills, communication skills, IT skills, time management skills and interpersonal skill

5. What you will learn

The intended learning outcomes of the programme (what students should know, understand and be able to do at the end of the programme), can be described under the following headings:

- Subject knowledge and understanding
- Subject specific skills
- Intellectual skills
- Key or transferable skills (including employability skills)

Subject knowledge and understanding

Successful students will be able to demonstrate knowledge and understanding of:

- knowledge of the fundamental principles of Physics and competence in applying these principles to diverse areas of the subject
- the ability to solve problems in Physics using appropriate mathematical tools including the ability to make sensible approximations
- the ability to execute, and analyse critically, an experiment or investigation and draw valid conclusions. You will be able to estimate the level of uncertainty in your results and compare these results with expected outcomes, theoretical predictions or with published data. You will be able to evaluate the significance of your results in this context
- If you specialise in Physics, via major honours, in your final year you develop a wider knowledge and understanding of advanced topics and their applications and acquire skills in the critically reading and understanding published work in Physics

Subject specific skills

Successful students will be able to:

- the ability to work safely in a laboratory and to have a knowledge and awareness of standard safety procedures
- a sound familiarity with laboratory apparatus and techniques;
- competent use of appropriate IT packages/systems for the analysis of data and the retrieval of information
- an ability in numerical manipulation and estimation and the ability to present and interpret information graphically
- an ability to use mathematical techniques and analysis to model physical behaviour;
- an ability to record and communicate scientific information, in particular through clear and accurate scientific reports
- an ability to question, learn and assimilate knowledge and to evolve your views of the world in response to that new knowledge
- an ability to contribute through research to the development of knowledge in Physics
- (if you Major in Physics in your final year) an ability to acquire knowledge and understanding of science for yourself, and to work productively on scientific problems on an individual basis

Intellectual skills

Successful students will be able to:

- analyse and solve problems
- evaluate evidence and make critical judgements
- interpret and critique text
- interpret and critique mathematical and numerical information
- abstract and synthesise information
- develop a reasoned argument
- assess contrasting theories, explanations and policies
- take responsibility for your own learning and critique that learning

Key or transferable skills (including employability skills)

Successful students will be able to:

- the ability to manage your own learning and to make appropriate use of text books, research-based materials and other learning resources
- the ability to find information and make responsible use of it
- the ability to listen
- the ability to make effective written and oral presentations
- the ability to work with numerical data
- the ability to make sensible estimates
- an awareness of the costs and benefits of your actions
- the ability to work effectively with a variety of types of Information Technology
- the ability to plan, manage, execute and report an investigation
- the ability to learn and gain understanding
- the ability to work effectively both as an individual and as part of a team
- the ability to sustain motivation for an extended period of time
- a recognition of your responsibilities as an individual and as part of a team, an organisation

Keele Graduate attributes

Engagement with this programme will enable you to develop your intellectual, personal and professional capabilities. At Keele, we call these our ten Graduate Attributes and they include independent thinking, synthesizing information, creative problem solving, communicating clearly, and appreciating the social, environmental and global implications of your studies and activities. Our educational programme and learning environment is designed to help you to become a well-rounded graduate who is capable of making a positive and valued contribution in a complex and rapidly changing world, whichever spheres of life you engage in after your studies are completed.

Further information about the Keele Graduate Attributes can be found here: http://www.keele.ac.uk/journey/

6. How is the Programme taught?

Learning and teaching methods used on the programme vary according to the subject matter and level of the module. They include the following:

- Lectures
- Tutorials
- Laboratory Classes
- Exercise/Problem-Solving Classes
- Individual Progress Interviews
- Problem Sheet Assignments
- Group and Individual projects
- Directed Reading and Independent Study
- Use of e-learning/the Keele Learning Environment (KLE)

Apart from these formal activities, students are also provided with regular opportunities to talk through particular areas of difficulty, and any special learning needs they may have, with their Personal Tutors or module lecturers on a one-to-one basis.

These learning and teaching methods enable students to achieve the learning outcomes of the programme in a variety of ways.

7. Teaching Staff

The Physics academic staff exhibit a research profile with two main areas of expertise; namely astrophysics and condensed matter physics. Most also undertake administrative roles, either within our teaching or research activities.

The University will attempt to minimise changes to our core teaching teams, however, delivery of the programme depends on having a sufficient number of staff with the relevant expertise to ensure that the programme is taught to the appropriate academic standard.

Staff turnover, for example where key members of staff leave, fall ill or go on research leave, may result in changes to the programme's content. The University will endeavour to ensure that any impact on students is limited if such changes occur.

8. What is the Structure of the Programme?

The academic year runs from September to June and is divided into two semesters. The number of weeks of teaching will vary from course to course, but you can generally expect to attend scheduled teaching sessions between the end of September and mid-December, and from mid-January to the end of April.

Our degree courses are organised into modules. Each module is usually a self-contained unit of study and each is usually assessed separately with the award of credits on the basis of 1 credit = 10 hours of student effort. An outline of the structure of the programme is provided in the tables below.

There are four types of module delivered as part of this programme. They are:

- Compulsory core module – a module that you are required to study on this course;
- Optional core module – these allow you some limited choice of what to study from a list of modules;
- Programme approved elective module – subject-related modules that count towards the number of subject credits required by your degree;
- Free-standing elective module – a free choice of modules that count towards the overall credit requirement but not the number of subject-related credits.

The Physics Principal Course is modular in structure, and is taken in combination with another principal subject as part of a Dual Honours course. At the end of year 2 (level 5), you may also be able to specialise in one of your two principal subjects in your final year.

Year 1 (Level 4)

At level 4, Physics and Astrophysics students require a common knowledge and skills base. Therefore, many of the modules taught at level 4 are common to both disciplines. You will study FOUR lecture-based modules of core Physics.

The lecture-based modules are supported by problem classes and assessed problem sheets with an end of semester examination in each. These modules also include lectures, problems classes and tutorials in mathematics, and laboratory classes, which are an essential part of physics. The module descriptors provide detailed synopses of each module with suggested study reading and are available on the KLE.

Compulsory Core modules	**Credits**	**Elective modules**	**Credits**
Mechanics, Gravity and Relativity	15	None	

Nature of Matter	15		
Oscillations and Waves	15		
Electricity and Magnetism	15		

Year 2 (Level 5)

At level 5 you continue to be taught the fundamentals of Physics. Modules are common to Physics and Astrophysics in the first semester of the second year, but diverge significantly from the second semester of the second year onwards.

In the first semester you take an Optics Laboratory and a short series of classes in developing your mathematical skills. In the second semester you take an instrumentation and measurement laboratory incorporating a mini-project.

Compulsory Core modules	**Credits**	**Elective modules**	**Credits**
Quantum Mechanics	15	None	
Optics and Thermodynamics	15		
Statistical mechanics and Solid State Physics	15		
Nuclear and Particle Physics	15		

Year 3 (Level 6)

At level 6, you complete an independent research project and follow one compulsory module plus either two (dual honours) or three (major route) optional core modules of your choice from a list of available modules.

Compulsory Core modules	**Credits**	**Optional Core modules**	**Credits**
Physics Project	15	Cosmology	15
Electromagnetism	15	Physics of the Interstellar Medium	15
Dissertation and Communication Skills [Major route]	15	The Physics of Compact Objects	15
		Quantum Physics of Atoms and Molecules	15
		Polymer Physics	15
		Particle Physics and Accelerators	15
		Binary Stars and Extrasolar Planets	15
		Life in the Universe	15
		Computational Methods in Physics and Astrophysics	15
		Data Analysis and Model testing	15
		The Physics of Galaxies	15
		Quantum Mechanics II	15
		Physics of Fluids	15
		Atmospheric Physics	15
		Plasma Physics	15

You may, in addition to modules listed, include in level 6 of your Physics course one suitable programme approved elective module from another Principal Course, provided that you are not taking the Principal Course from which that module is derived as part of your Dual Honours combination.

You will find that in teaching you we put emphasis on problem solving. This occurs in examples classes where you solve practice problems in physics in class with staff to assist you, in laboratory teaching where you will be expected to address practical problems and in your directed work for assessment. You are encouraged to call upon module leaders and the director of study for guidance. The staff will be willing to see you at almost any time and you will have one-to-one progress interviews each semester. The teaching team will monitor your

progress and we will contact you if we find that you are not achieving all that you should and advise you on how to improve.

You will benefit from a flexible approach to learning the mathematical skills that are essential to the learning and application of Physics. You will find that the classes on mathematics in level 4 are presented in a series of blocks. An assessment test is taken at the end of the class blocks. You will also attend supplementary supporting tutorials in mathematics.

For further information on the content of modules currently offered please visit:
www.keele.ac.uk/recordsandexams/az

Learning Outcomes

Year 1 (Level 4)

Learning Outcome *Successful students will be able to demonstrate knowledge & understanding of:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
Understand basic concepts in mechanics, nature of matter, oscillation and waves and electricity and magnetism. Demonstration of this understanding by solving physical problems. Understanding of mathematical techniques necessary for application to physics. Perform practical work and keep accurate accounts of it, including professionally maintained records of purpose, methodology, and results. Communicate the process and results of practical work in formal, written presentations. Enter, manipulate, and present data with the aid of computer tools.	Mechanics, Gravity and Relativity Nature of Matter Oscillations and Waves Electricity and Magnetism	Laboratory diary and laboratory reports; problem classes and problem sheets; unseen two hour exam and class tests.

Year 2 (Level 5)

Learning Outcome *Successful students will be able to:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
Comprehensive understanding of the relevant theoretical and experimental background of quantum mechanics, optics, thermodynamics, nuclear physics, particle physics, statistical mechanics and solid state physics.	Quantum Mechanics Optics and Thermodynamics Statistical mechanics and Solid State Physics Nuclear and Particle Physics	Problem Sheets Unseen examination Engagement with problem classes

Can use range of established techniques for critical analysis of numerical calculations in connection with problems in quantum mechanics, optics, thermodynamics, nuclear physics, particle physics, statistical mechanics and solid state physics.	Quantum Mechanics Optics and Thermodynamics Statistical mechanics and Solid State Physics Nuclear and Particle Physics	Problem Sheets Unseen examination Engagement with problem classes
Extended abilities in the execution and reporting of laboratory work within the context of physics.	Optics and Thermodynamics	Engagement with laboratory classes Laboratory reports
Experience of working in a team on a short physics project.	Nuclear and Particle Physics	Assessed by laboratory work and reports completed during the semester

Year 3 (Level 6)

Learning Outcome *Successful students will be able to:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
Successful students will have gained an understanding of the central role played by the theory of electromagnetism in describing the universe and the world around them and be able to tackle problems and calculations in electromagnetism at a level appropriate to a final year honours degree course.	Electromagnetism	Continuously assessed problem sheets and examination.
Demonstrate good comprehension, planning and execution of a project. Ability to give a short presentation on the progress of the project. Production of a clear, accurate and informative project report. Demonstrate a good understanding of the literature associated with the project theme.	Physics Project	Outcomes assessed by the presentation, benchwork and by the project report.
A successful student will be familiar with cosmological observations and be able to apply basic physics principles to the universe as a whole. A successful student will be able to calculate conditions in the universe at different times and use mathematics to relate the theory with the observations.	Cosmology	Outcomes are assessed by problems sheets and unseen examination.
Knowledge of the contents of the	Physics of the Interstellar Medium	Problem sheets and unseen

ISM. Understand and appreciate the impact of stars on the ISM. Carry out quantitative calculations to support the above How the above is determined, observationally and by the application of basic Physics Understand the interaction between different components of this ISM		examination
Successful students will be able to demonstrate that they understand the properties of degenerate matter and that they appreciate the difference between normal and compact stars. They will understand how microscopic physical laws can be applied to macroscopic systems. They will understand how the structures of compact stars are determined and be aware of the importance of an accurate equation of state. They will appreciate how observations of compact stars can be used to probe physical laws at very high densities and be aware of the most recent research on the subject.	The Physics of Compact Objects	Outcomes are assessed by problems sheets and unseen examination.
The ability to apply quantitative techniques of quantum mechanics to straightforward problems in atomic and molecular physics. A detailed understanding the quantum behaviour of atoms in external electric and magnetic fields. The ability to solve a range of time-dependent quantum mechanical problems. The ability to understand aspects of atomic and molecular spectroscopy in a semi-quantitative fashion. An understanding of the nature of molecular wave- functions. An understanding of the links between classical and quantum physics.	Quantum Physics of Atoms and Molecules	Problem sheets and unseen examination
An understanding of the structure	Polymer Physics	Outcomes are assessed by

of polymer molecules and the application of physical characterisation techniques. An understanding of crystallinity and molecular orientation in polymer materials; application of physical techniques to determine the crystallinity and molecular orientation in polymer materials. An understanding of macrostructure in polymer materials; application of small angle x-ray scattering (SAXS) techniques to probe macrostructure in polymer materials. An understanding of microstructure in polymer materials; application of wide-angle x-ray scattering (WAXS) techniques to probe microstructure in polymer materials. An understanding of mechanical properties of polymer materials and their yield behaviour.		problems sheets and unseen examination.
Successful students will be able to collect information on physics topics and present to a peer group by an oral presentation and poster presentation. Successful students will be able to assemble and review information on a specific topic and produce a substantial, detailed dissertation.	Dissertation and Communication Skills	Outcomes are assessed by oral presentation, poster presentation and dissertation.
Detail the elementary particles, fundamental forces, symmetries and conservation laws of the Standard Model, and apply these to analyse particle reactions and decays. Use the quark model, isospin formalism and basic quantum mechanics to classify hadrons, determine their internal structures and explain their properties. Employ special relativity and quantum mechanics to calculate and analyse a range of physical phenomena, processes and experiments involving elementary and subatomic particles. Describe and apply some of the key	Particles, Accelerators and Reactor Physics	Examination paper, problems sheets and essay.

ideas, empirical foundations and predictions of quantum theories for the strong and electroweak forces. Derive and use equations to calculate the relativistic and non-relativistic dynamics of particles and beams in linear and circular accelerators and colliders. Compare and contrast the operation and design principles, advantages and limitations of the main types of particle accelerators. Explain neutron-induced fission and the neutron cycle in thermal fission reactors, and derive and apply basic equations governing reactor operation. Research and report at a third-year undergraduate level on the physics of an application or an operational aspect of particle accelerators or nuclear reactors.		
Successful students will: Demonstrate a systematic understanding and detailed knowledge of the physics of binary stars and extrasolar planets, their evolution and interactions. Have acquired coherent and detailed knowledge of the methods used to discover and characterise of extrasolar planets and some knowledge of recent developments as the forefront of these subjects. Be able to apply established techniques of analysis to data from primary sources for eclipsing extrasolar planets and binary stars. To make judgements regarding the quality of the data and the limits of the information that can be extracted from the data.	Binary Stars and Extrasolar Planets	Outcomes are assessed by problems sheets, unseen examination and computer- based simulation exercises. Formative assessment through tutorial engagement.
Students will have acquired: Systematic understanding of the physical processes that govern the formation and evolution of planets, planetary atmospheres and Life. Coherent and detailed knowledge of the possibilities and limitations of searches for extra-solar planets	Life in the Universe	Outcomes are assessed by problems sheets, unseen examination and a mini project.

and extra-terrestrial Life. Skills to exercise initiative in designing and executing an experiment, and to communicate ideas related to the experiment's context and objective. Be able to critically evaluate the possibilities and limitations of interstellar travel and communication.		
Has systematic understanding of the principles behind a variety of computational and numerical techniques that are commonly used in physical and astrophysical research. Students will acquire the knowledge to identify the appropriateness of computational and numerical approaches in a variety of situations and able to deploy them appropriately. To acquire skills in using a high-level computational language to implement and apply numerical techniques to physical and astrophysical problems. To demonstrate the ability to communicate the results of numerical calculations in written and graphical formats.	Computational Methods in Physics and Astrophysics	Outcomes are assessed by problem Sheets, unseen examination and project.
Has systematic understanding of statistical techniques used to analyse and interpret physical/astrophysical data. Has conceptual understanding that enables the student to solve data analysis problems and to interpret scientific data, using statistical ideas and modern analysis techniques. Can critically evaluate data from primary sources to make and communicate judgements by applying established numerical analysis techniques to physical/astrophysical data.	Data Analysis and Model testing	Outcomes are assessed by problem sheets, project and practical examination.
Describe quantitatively the structure and dynamics of the Milky Way Galaxy and its main components, and how these relate	The Physics of Galaxies	Outcomes are assessed by problems sheets and unseen examination.

to other galaxies. Analyse the structure and dynamics of galaxies, star clusters, and clusters of galaxies, using advanced classical mechanics and Newtonian gravity. Interpret physically the properties of normal galaxies along the Hubble sequence, including scaling relations and connections to dark matter. Calculate physical processes in the nuclei of galaxies involving accretion onto black holes and the emission and absorption of radiation. Apply fundamental physics to calculate the dynamical state of groups and clusters of galaxies, their intracluster gas, and their dark matter content. Describe large-scale structure in the Universe, the nature of the first galaxies, and their implications for dark matter and cosmology.		
Describe and apply standard approximation techniques used in quantum mechanics. Describe the main concepts and results in a recent peer-reviewed journal article the application or interpretation of quantum physics. Analyse the rotation-vibration spectrum or Raman spectrum of a diatomic molecule. Describe and explain phenomena such as quantum entanglement and quantum teleportation. Discuss the merits of and problems with different proposed interpretations of quantum mechanics in the light of experimental results. Describe applications of quantum mechanics such as quantum dots and quantum cryptography and quantum computing. Interpret and apply Dirac bra-ket notation.	Quantum Mechanics II	Outcomes are assessed by problems sheets, article and unseen examination.

Calculate the results of simple physical processes involving electrons using Pauli spin matrices.		
Understand the basic principles and laws governing the physics of fluids (e.g. momentum/Euler equations) Apply the laws of fluid dynamics to specific topics found in nature and space (e.g. tsunamis) Use computer programs to solve basic problems in fluid dynamics Manipulate the equations of fluid dynamics in an applied context and numerically solve related problems Analyse and interpret complex processes like convection in the framework of fluid dynamics theory, making reasonable approximations	Physics of Fluids	Outcomes are assessed by problems sheets and unseen examination.
Describe quantitatively the structure and dynamics of atmospheres. Use the principles of thermodynamics to determine the structure of atmospheres. Solve the equation of radiative transfer to evaluate the effect of radiation on atmospheric structure. Apply the laws of motion to describe atmospheric dynamics and waves.	Atmospheric Physics	Outcomes are assessed by problems sheets and unseen examination.
Describe the properties of a plasma, in both Physics and Astrophysics contexts. Use electromagnetic theory to describe quantitatively the motion of charged particles. Use electromagnetic theory to describe quantitatively the propagation of an electromagnetic wave through a magnetised and unmagnetised plasma. Describe the nature and origin of electromagnetic and other waves that propagate in a plasma. Describe how the properties of a plasma, both natural and artificial, are determined, using techniques such as spectroscopy.	Plasma Physics	Outcomes are assessed by problems sheets, essay and unseen examination.

Describe how plasmas arise, in both natural and artificial contexts.		

9. Final and intermediate awards

Credits required for each level of academic award are as follows:

Honours Degree	360 credits	You will require at least 120 credits at levels 4, 5 and 6 The number of Physics credits a student requires depends on whether Physics is taken as a Dual, Major or Minor subject. **Dual Honours:** You will require a total of 360 credits in both Physics and your other Principal subject, with a total 120 credits, including 60 credits in Physics, in each year of study. **Major Honours**: Where Physics is taken as a Major subject a student must obtain at least 225 credits in Physics and at least 90 credits in their other Minor subject over the course of their degree. Students taking Physics as a Major subject must obtain at least 60 credits in Physics at each of levels 4 and 5 and 105 credits in Physics modules at level 6. **Minor Route:** You will require at least 90 credits in Physics and at least 225 credits in your other Major subject over the course of the degree. Students taking Physics as a Minor subject must obtain at least 30 credits in Physics in Year 1 (level 4) and 45 credits in Physics in Year 2 (level 5).
Diploma in Higher Education	240 credits	You will require at least 120 credits at level 4 or higher and at least 120 credits at level 5 or higher
Certificate in Higher Education	120 credits	You will require at least 120 credits at level 4 or higher

Physics with International Year: in addition to the above students must pass a module covering the international year in order to graduate with a named degree in Physics with International Year. Students who do not complete, or fail the international year, will be transferred to the three-year Physics programme.

10. How is the Programme assessed?

The wide variety of assessment methods used within Physics at Keele reflects the broad range of knowledge and skills that are developed as you progress through the degree programme. Teaching staff pay particular attention to specifying clear assessment criteria and providing timely, regular and constructive feedback that helps to clarify things you did not understand and helps you to improve your performance. The following list is representative of the variety of assessment methods used within Physics:

- **End of module examinations** test the ability of the student to describe, explain, and critically discuss the principles of the subject and to demonstrate competence in applying these principles to applications and to solve problems from appropriate areas of the discipline.
- **Assessed Problem Sheets** assess the student's skills in solving numerical and other problems within the discipline by drawing on their scientific understanding and knowledge, and experience of experimental techniques

- **Laboratory and Project Reports** – structured proformas and full lab reports are formal summaries of work carried out in the laboratory and test students' understanding of the practical aspects of the programme and develop the skills necessary to enable students to present and analyse their results.

- **Observation of laboratory skills and laboratory notebooks**: Throughout the extensive laboratory and other practical work in this programme, many types of assessment are utilised to achieve the learning outcomes. Notebooks are used to communicate the results of work accurately and reliably and to encourage good working practice, including managing risk assessments and following safe working practices.

- **Oral and/or Poster presentations** on project work demonstrate the ability of the student to present complex concepts and information in a clear and concise manner, to interact and communicate effectively to a wide range of professional environments, including to both scientific and non-scientific audiences.

- **In-class exercises and tests** taken either conventionally or online via the Keele Learning Environment (KLE) assess students' subject knowledge and their ability to apply it in a more structured and focused way.

- **Individual or group oral presentations** assess individual student's subject knowledge and understanding. They also test their ability to work effectively as members of a team, to communicate what they know orally and visually, and to reflect on these processes as part of their own personal development.

Marks are awarded for summative assessments designed to assess your achievement of learning outcomes. You will also be assessed formatively to enable you to monitor your own progress and to assist staff in identifying and addressing any specific learning needs. Feedback, including guidance on how you can improve the quality of your work, is also provided on all summative assessments within three working weeks of submission, unless there are compelling circumstances that make this impossible, and more informally in the course of tutorial and seminar discussions.

Year 1 (Level 4) lecture modules are assessed by a mixture of continuous assessment (mostly in the form of problem classes and problem sheets) and examination. The skills component of these modules is assessed on your work at the bench, your understanding of the experiment as displayed in discussion with the staff in the laboratory and in the laboratory reports you are required to write. Problem classes and tests that occur periodically throughout the year assess the mathematics component. The computational strand is assessed by demonstration of use of computer code.

Year 2 (Level 5) lecture modules are assessed by a mixture of continuous assessment (mostly in the form of problem classes and problem sheets), laboratory work and examination. Laboratory work is assessed on your work at the bench, your understanding of the experiment as displayed in discussion with the staff in the laboratory and in the laboratory reports you are required to write. The laboratory work is connected to the content of the lecture modules and the marks for the laboratory are therefore convolved with the examination and continuous assessment marks to give a final mark for each module.

In Year 3 (Level 6) modules stand alone. Lecture modules are assessed using a mixture of continuous assessment (mostly in the form of problem sheets) and examination. The project modules are assessed in terms of the originality and ingenuity you display, the quality and methods of research employed and on the final report. You are given the opportunity to display these qualities in a project plan, an interim report, a one-to-one interview and in your final report. The Dissertation and Communication Skills module is assessed on the scientific content and presentation of the dissertation and also on an oral presentation and a poster presentation that you are required to produce

11. Contact Time and Expected Workload

This contact time measure is intended to provide you with an indication of the type of activity you are likely to undertake during this programme. The data is compiled based on module choices and learning patterns of

students on similar programmes in previous years. Every effort is made to ensure this data is a realistic representation of what you are likely to experience, but changes to programmes, teaching methods and assessment methods mean this data is representative and not specific.

Undergraduate courses at Keele contain an element of module choice; therefore, individual students will experience a different mix of contact time and assessment types dependent upon their own individual choice of modules. The figures below are an example of activities that a student may expect on your chosen course by year/stage of study. Contact time includes scheduled activities such as: lecture, seminar, tutorial, project supervision, demonstration, practical classes and labs, supervised time in labs/workshop, fieldwork and external visits. The figures are based on 1,200 hours of student effort each year for full-time students.

Activity	Year 1 (Level 4)	Year 2 (Level 5)	Year 3 (Level 6)
Scheduled learning and teaching activities	45%	44%	27%
Guided independent Study	55%	56%	73%
Placements	0%	0%	0%

12. Accreditation

This subject/programme is accredited by The Institute of Physics (IoP). Please note the following:

- Graduates with accredited BSc degrees are eligible for Associate Membership of the IoP. After a period of relevant post-degree experience and professional development they may apply for full membership of the IoP and for Chartered Physicist status.

13. Regulations

The University Regulations form the framework for learning, teaching and assessment and other aspects of the student experience. Further information about the University Regulations can be found at: http://www.keele.ac.uk/student-agreement/

A student who has completed a semester abroad will not normally be eligible to transfer onto the International Year option.

14. What are the typical admission requirements for the programme?

Subject	A-level	Subjects not included	International Baccalaureate	BTEC	Access to Higher Education Diploma	GCSE requirements
Physics (Dual Honours)	BBC A level Physics or Maths at grade B or above. If Maths is presented without A-level Physics, then a grade of C or better in AS-level Physics is also required.*** A Pass in Science Practical will be required if applicant is taking A level Physics (England)** ** Science practical only required from applicants taking reformed A level Biology, Chemistry or Physics in England.	General Studies and Critical Thinking	30 points to include Higher Level Physics at 5 or above or Higher Level Maths at 5 or above plus Higher Level Physics at 4 or above.	DDM - DMM You must have taken sufficient Physics units, please contact us for advice	Access to Higher Education Diploma with 45 Level 3 credits, including Distinction in at least 30 suitable Level 3 credits in Physics and Mathematics. Please contact us for advice.	Maths @ C (or 4) if not taken at A level or AS-level. English Language @ C (or 4)

	*** If applicant has not had opportunity to sit AS level in England, please contact admissions@keele.ac.uk					

Applicants who are not currently undertaking any formal study or who have been out of formal education for more than 3 years and are not qualified to A-level or BTEC standard may be offered entry to the University's Foundation Year Programme.

Applicants for whom English is not a first language must provide evidence of a recognised qualification in English language. The minimum score for entry to the Programme is Academic IELTS 6.0 or equivalent.

Please note: All non-native English speaking students are required to undertake a diagnostic English language assessment on arrival at Keele, to determine whether English language support may help them succeed with their studies. An English language module may be compulsory for some students during their first year at Keele.

Accreditation of Prior Learning (APL) is considered on a case-by-case basis and those interested should contact the Programme Director. The University's guidelines on this can be found here:
http://www.keele.ac.uk/qa/accreditationofpriorlearning/

15. How are students supported on the programme?

Keele Learning Environment (KLE)

All the Physics modules are supported by learning materials that are accessible to students via the KLE at https://students.keele.ac.uk/webapps/login/. Online guideline and support for KLE is available at:
http://www.keele.ac.uk/klehelp/

Personal Tutor

All the students are assigned a Personal Tutor as a part of University's Personal Tutor system for their duration of studies at Keele. There is a formal requirement for the Personal Tutors to meet with their first year tutees during the first week of the semester one. Subsequently, Personal Tutors should meet at least four times per year to discuss progress and offer support and advice. During the subsequent undergraduate years Personal Tutors should meet at least three times per year. Students can make arrangement to seek help or advice on any matter that affects their life and work as a student at Keele. More details available at:
http://www.keele.ac.uk/personaltutoring/

Year Tutor

Each year of study has an associated Year Tutor who monitors the students and the modules to ensure the course is running smoothly and that you are making progress as you should. They will note any problems and bring them to the attention of the Course Management Committee who will decide on an appropriate course of action. You should regard the year tutor as your first point of contact to discuss any topic related to the courses or your own academic performance.

Student with disabilities

If you have long-term disabilities, you will have the assistance of the Disability Coordinator and the Examinations Office and from academic and support staff who liaise with these services.

Health and Safety

All the students are briefed on the health and safety as part of their induction and repeated again at the beginning of the first laboratory session. Students are required to sign an agreement that they have read the Safety Handbook, and that they will abide by the rules and regulations governing the safety and welfare of all members within the University. The Safety handbook can be accessed from physics web page at:
http://www.keele.ac.uk/physics

Further information

It is essential that students check the Physics web page (http://www.keele.ac.uk/physics) and KLE (http://students.keele.ac.uk/) for up to date information on course and teaching materials related to their Physics modules.

16. Learning Resources

The Physics and Astrophysics section of the School is housed in Lennard Jones Building, which contains well-equipped undergraduate Physics teaching laboratories and a dedicated PC laboratory supporting both Windows and Linux. There are rooms available in the building for the students to work and socialise with their peers. There are dedicated boxes located in the building for submission of the problem sheets and laboratory reports. In addition, the School Office is open continuously during the week from 9am to 5pm to answer student queries.

17. Other learning opportunities

Study abroad (semester)

Students on the Physics programme have the potential opportunity to spend a semester abroad in their second year studying at one of Keele's international partner universities.

Exactly which countries are available depends on the student's choice of degree subjects. An indicative list of countries is on the website (http://www.keele.ac.uk/studyabroad/partneruniversities/); however this does not guarantee the availability of study in a specific country as this is subject to the University's application process for studying abroad.

No additional tuition fees are payable for a single semester studying abroad but students do have to bear the costs of travelling to and from their destination university, accommodation, food and personal costs. Depending on the destination they are studying at additional costs may include visas, study permits, residence permits, and compulsory health checks. Students should expect the total costs of studying abroad to be greater than if they study in the UK, information is made available from the Global Education Team throughout the process, as costs will vary depending on destination

Whilst students are studying abroad any Student Finance eligibility will continue, where applicable students may be eligible for specific travel or disability grants. Students studying in Erasmus+ destinations may be eligible for grants as part of this programme. Students studying outside of this programme may be eligible for income dependent bursaries at Keele.

Students travel on a comprehensive Keele University insurance plan, for which there are currently no additional charges. Some governments and/or universities require additional compulsory health coverage plans; costs for this will be advised during the application process.

Study Abroad (International Year)

A summary of the International Year, which is a potential option for students after completion of Year 2 (Level 5), is provided at Annex A.

Other opportunities

Also there are other opportunities such as *Physics Ambassador Scheme* and *e-mentoring scheme* for students to enhance their employability skills.

18. Additional costs

As to be expected there will be additional costs for inter-library loans and potential overdue library fines, print and graduation.

19. Quality management and enhancement

The quality and standards of learning in Physics are subject to a continuous process of monitoring, review and enhancement.

- The Learning and Teaching Committee of the School of Chemical and Physical Sciences is responsible for reviewing and monitoring quality management and enhancement procedures and activities across the School.
- Individual modules and the Physics Programme as a whole are reviewed and enhanced every year in the annual programme review which takes place at the end of the academic year and as part of the University's Curriculum Annual Review and Development (CARD) process.
- The programmes are run in accordance with the University's Quality Assurance procedures and are subject to periodic reviews under the Internal Quality Audit (IQA) process.

Student evaluation of, and feedback on, the quality of learning on every Physics module takes place every year using a variety of different methods:

- The results of student evaluations of all modules are reported to module leaders and reviewed by the Physics and Astrophysics Course Management Committee (CMC) as part of the Curriculum Annual Review and Development (CARD) process.
- Findings related to the Physics Programmes from the annual National Student Survey (NSS), and from regular surveys of the student experience conducted by the University, are subjected to careful analysis and a planned response at programme and School level.
- Feedback received from representatives of students in all three years of the Physics Programme is considered and acted on at regular meetings of the Programmes Staff/Student Liaison Committee.

The University appoints senior members of academic staff from other universities to act as external examiners on all programmes. They are responsible for:

- Approving examination questions
- Confirming all marks which contribute to a student's degree
- Reviewing and giving advice on the structure and content of the programme and assessment procedures

Information about current external examiner(s) can be found here:
http://www.keele.ac.uk/qa/externalexaminers/currentexternalexaminers/

Physics programmes are also accredited by the Institute of Physics (IoP). As part of the accreditation process, every five years a visiting panel from the IoP audits all aspects of the Physics programmes.

20. The principles of programme design

The Physics Programmes described in this document have been drawn up with reference to, and in accordance with the guidance set out in, the following documents:

a. UK Quality Code for Higher Education, Quality Assurance Agency for Higher Education:
http://www.qaa.ac.uk/assuring-standards-and-quality/the-quality-code

b. QAA Subject Benchmark Statement: Physics, Astronomy and Astrophysics (2008)
http://www.qaa.ac.uk/en/Publications/Documents/Subject-benchmark-statement-Physics-astronomy-and-astrophysics.pdf

c. The Institute of Physics Accreditation Scheme for First Degree Courses in Physics
http://www.iop.org/activity/policy/Degree_Accreditation/Application Process/page_26579.html

d. Keele University Regulations and Guidance for Students and Staff: http://www.keele.ac.uk/regulations

21. Document Version History

Version history	Date	Notes
Date first created	October 2016	
Revision history	V2.0: May 2017	Revised year 3 optional module (Particle Physics & Accelerators) [minor change – no reissue]
Date approved	06/06/17	

Annex A for Dual Honours Programmes

Please note: in order to be eligible to take the International Year option your other subject must also offer this option. Please refer to the information published in the course document for your other subject.

International Year Programme

Students registered for Dual Honours **Physics** may either be admitted for or apply to transfer during their period of study at Level 5 to the Dual Honours programme in both their principal subjects, providing that they meet the progression criteria outlined in this document. Students accepted onto the International Year programme will have an extra year of study at an international partner institution after they have completed Year 2 (Level 5) at Keele.

Students who successfully complete both the second year (Level 5) and the International Year will be permitted to progress to Level 6. Students who fail to satisfy the examiners in respect of the International Year will normally revert to the Dual Honours programme without the International Year and progress to Level 6 on that basis. The failure will be recorded on the student's final transcript.

Study at Level 4, Level 5 and Level 6 will be as per the main body of this programme specification. The additional detail contained in this annex will pertain solely to students registered for 'Physics with International Year'.

International Year Programme Aims

In addition to the programme aims specified in the main body of the programme specification, the international year programme of study aims to provide students with:

1. Personal development as a student and a researcher with an appreciation of the international dimension of their subject
2. Experience of a different culture, academically, professionally and socially

Entry Requirements for the International Year

Students may apply to the 4-year programme during Level 5. Admission to the International Year is subject to successful application, interview and references from appropriate staff.

The criteria to be applied are:

- Academic Performance (an average of 60% across all modules at Level 5 is normally required)
- General Aptitude (to be demonstrated by application for study abroad, interview during the 2nd semester of year 2 (Level 5), and by recommendation of the student's personal tutor, 1st and 2nd year tutors and programme director)

Student Support

Students will be supported whilst on the International Year via the following methods:

- Phone or Skype conversations with Study Abroad tutors, in line with recommended Personal Tutoring meeting points.
- Support from the University's Global Education Team

Learning Outcomes

In addition to the learning outcomes specified in the main text of the Programme Specification, students who complete a Keele undergraduate programme with International Year will be able to:

a. Describe, discuss and reflect upon the cultural and international differences and similarities of different learning environments
b. Discuss the benefits and challenges of global citizenship and internationalisation
c. Explain how their perspective on their academic discipline has been influenced by locating it within an international setting.

In addition, students who complete 'Physics with International Year' will be able to:

i) Engage effectively in academic and scientific discourse in an international setting;
ii) Integrate, apply and develop fundamental physical principles to describe and explain phenomena and solve problems within the context of specialised areas of Physics.

Please note that students on Dual Honours programmes with International Year must meet the subject-specific learning outcomes for BOTH their principal subjects.

These learning outcomes will all be assessed by the submission of a satisfactory individual learning agreement, the successful completion of assessments at the partner institution and the submission of the reflective portfolio element of the international year module.

Course Regulations

Students registered for the 'Physics with International Year' are subject to the course specific regulations (if any) and the University regulations. In addition, during the International Year, the following regulations will apply:

Students undertaking the International Year must complete 120 credits, which must comprise *at least 40%* in the student's discipline areas.

This may impact on your choice of modules to study, for example you will have to choose certain modules to ensure you have the discipline specific credits required.

Students are barred from studying any 'Physics with International Year' module with significant overlap with Level 6 modules to be studied on their return. Significant overlap with Level 5 modules previously studied should also be avoided.

Additional costs for the International Year

Tuition fees for students on the International Year will be charged at 15% of the annual tuition fees for that year of study, as set out in Section 1. The International Year can be included in your Student Finance allocation, to find out more about your personal eligibility see: www.gov.uk

Students will have to bear the costs of travelling to and from their destination university, accommodation, food and personal costs. Depending on the destination they are studying at additional costs may include visas, study permits, residence permits, and compulsory health checks. Students should expect the total costs of studying abroad be greater than if they study in the UK, information is made available from the Global Education Team throughout the process, as costs will vary depending on destination.

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